SRI International

# 2010 NSF Large Facility Workshop

## *Engineering approach to Production, Supply, Replication of Facility Components and Systems*

Moyra Malone
AMISR Program Production Manager
May 5, 2010

# AMISR Program
## Overview

- The Introduction

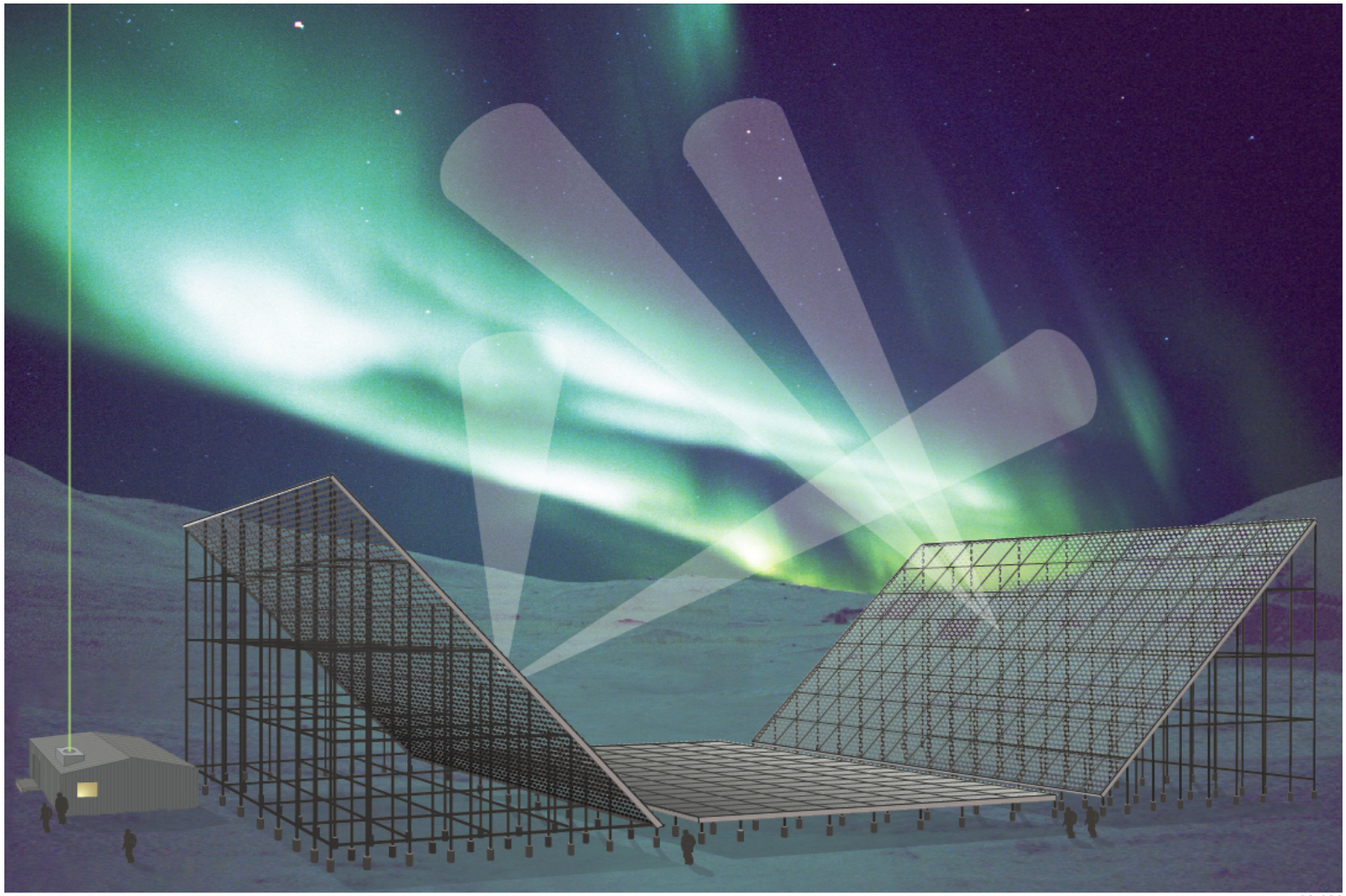
- AMISR Product
  - Research, innovation & commercialization of a product

- AMISR Program
  - Engineering Approach to Production, Supply & Replication of Facility Components and Systems
    - Advice Steps
      - Program Plan
      - Design Methodology
      - Product Documentation
      - Supply Chain
      - Manufacturing Process
      - Product Costing
      - Product Assembly
      - Product Test
      - Replication
  - Recommendation

# AMISR Program

- *The Introduction*
  - *What is AMISR?*
  - *Who am I?*

# Advanced Modular Incoherent Scatter Radar (AMISR)
## Engineering Concept, SRI International, 2001



# What's new about the Advanced Modular Incoherent Scatter Radar (AMISR)?

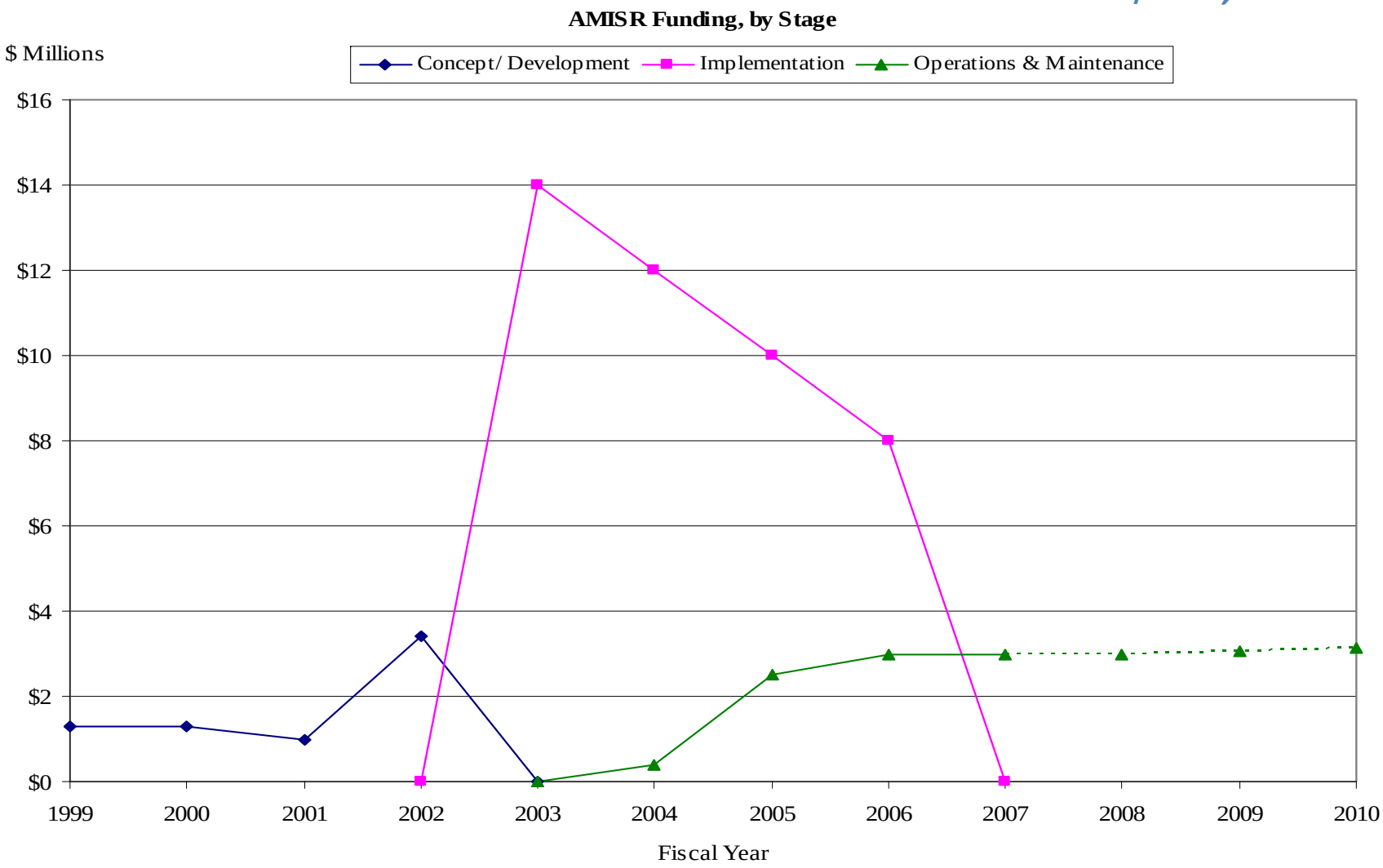
By Bob Robinson

National Science Foundation

- **First phased-array, solid-state incoherent scatter radar; allows for remote access without the need for on-site staff**
- **First incoherent scatter that allows for continuous, low duty cycle observations**
- **First modular incoherent scatter radar designed for easy dismantling and relocation**

# AMISR Program
## NSF Funding

- *09/1999-09/2011*
  - *$68M, Total Funding*

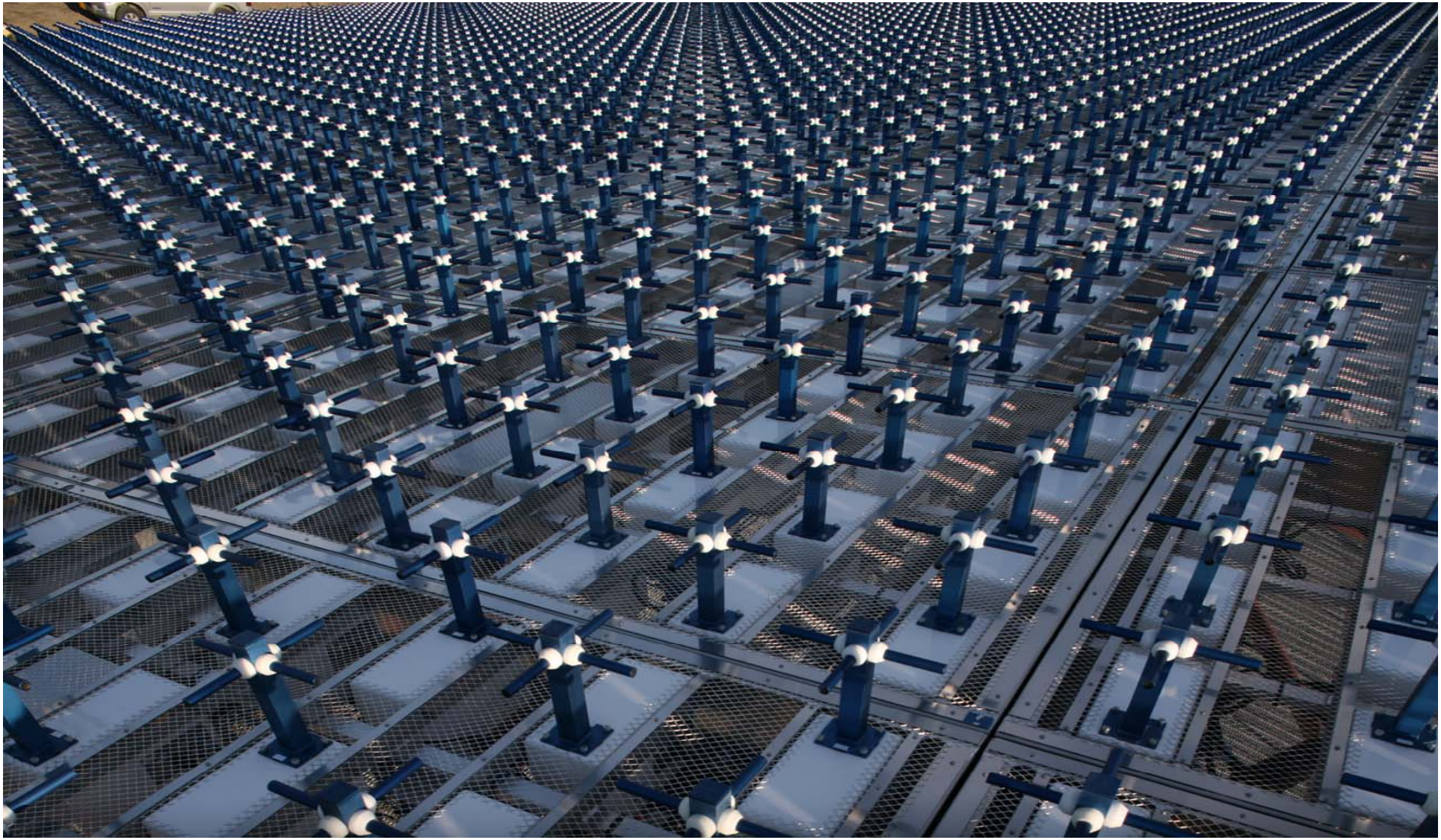



Data_NSF Reports

# AMISR Program
## Completion

- PFISR_One Radar installed at Poker Flat, Alaska
- RISR_One Radar installed in Resolute Bay, Canada
- Smaller installations
  - HAARP Site, Alaska
  - Jimarca, Peru

# AMISR Program
## PFISR_Cross Dipole Antenna View



# AMISR Program
## PFISR_Poker Flat, Alaska

# AMISR Program

## RISR=Resolute Bay, Canada, North Face

# AMISR Program
## Scaled Versions

HAARP Site, Alaska
University of Alaska

Jimarca, Peru @ Magnetic Equator
Cornell University

# Moyra Malone
## Brief Bio

- Background
  - Engineering Graduate, National University of Ireland-Galway
- Various Engineering & Operations Director positions
  - Westinghouse Corporation, Ireland and Baltimore, MD
  - Maxoptix Corporation, Silicon Valley
  - InVision Technologies/GE Security, Silicon Valley
  - **SRI International, AMISR Production Manager 2001+, Silicon Valley**
- Forte is in 'bridging the gap', or the 'chain link', between engineering concepts & ideas, and turning these ideas into products.
- The T& E in STEM. Not S or M.
- Product Launch Management
- Multi Disciplinary Engineering

# AMISR Program
## Science Instrument i.e. a Product Journey

*"Research, Innovation and Commercialization" of a product*

- Innovation process
  - Take researchers 'model/proof of concept', and turn it into a 'producible product'
  - Engineering Model always needs a 'LITTLE refinement'

- The Technology
  - AMISR covers all facets
    - Systems/Software Engineering
    - Materials Engineering
    - Sheet Metal Fabrication
    - Printed Circuit Technologies
    - Cabling/Interconnects

# AMISR Program
## Science Instrument i.e. Product Journey

- Commercialization….
  - SRI is a Research Center
    - not a production facility
  - Form Strategic Partnerships with the Supply Chain
    - Selected major players, having global presence
    - Cost of Product, understand the budget
    - Sanmina-sci, Avnet, NXP and other local facilities that could respond to schedule and cost
    - Availability of design engineers on staff
      - Supplement the SRI technical base
  - Technology Transfer and Challenges
    - When is the design 'good enough'?
    - Product to survive the environment, with an expected 20 year life cycle.
    - Design Engineer's product knowledge
      - Transfer to Manufacturing and Test Engineer's Instructions

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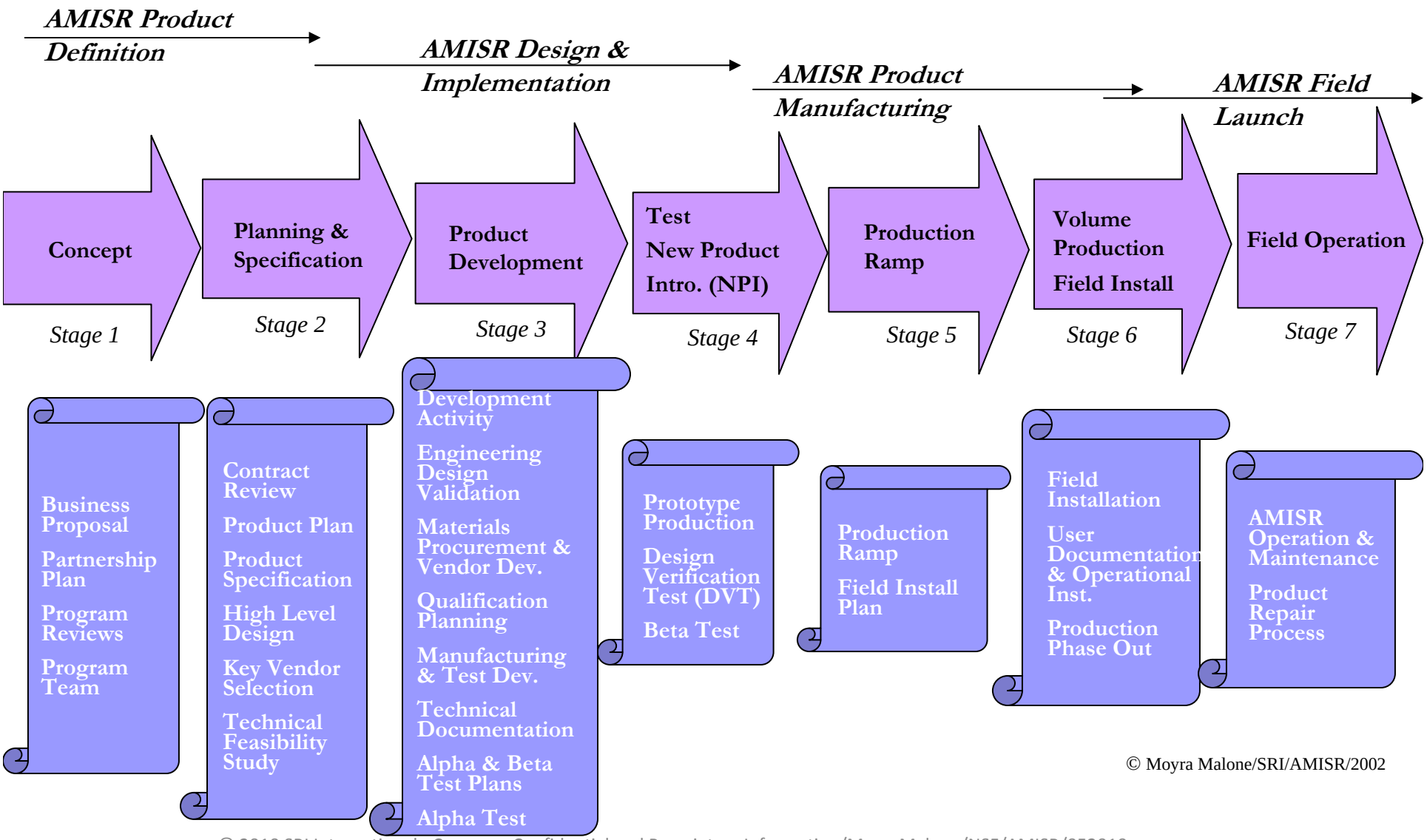
# AMISR Program

*Engineering approach to Production, Supply, Replication of*
*Facility Components and Systems*

# AMISR Program
## Advice Steps_Program Plan

- **Always**
  - ***"Make a Plan".***

# AMISR Program
## Product Life Cycle Process



# AMISR Program
## Advice Steps_Design Methodology

- **Design the product using the concept of DFx**

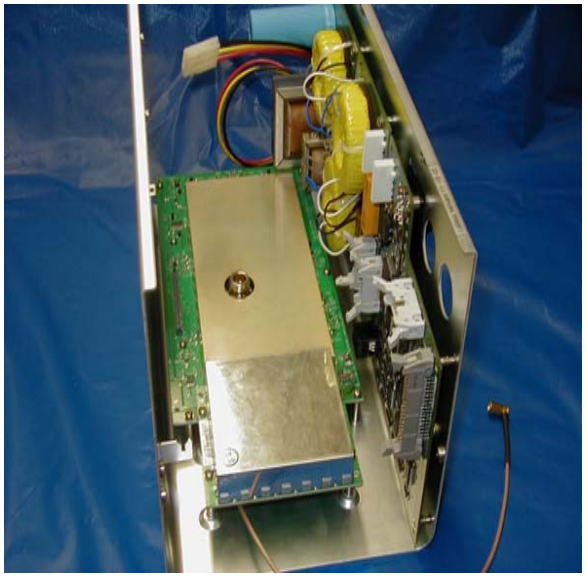
- **DF*x*, *where x=***
  - ***For the Environment***
  - ***For Reliability***
  - ***For Manufacturability***
  - ***For Assembly***
  - ***For Test***

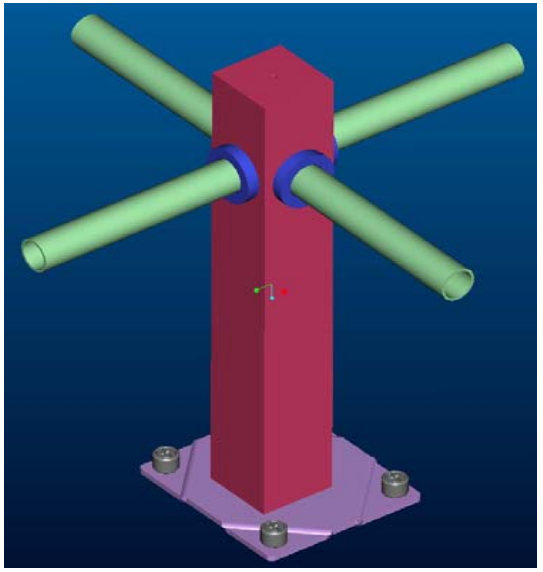
# AMISR Program
## Engineering Design

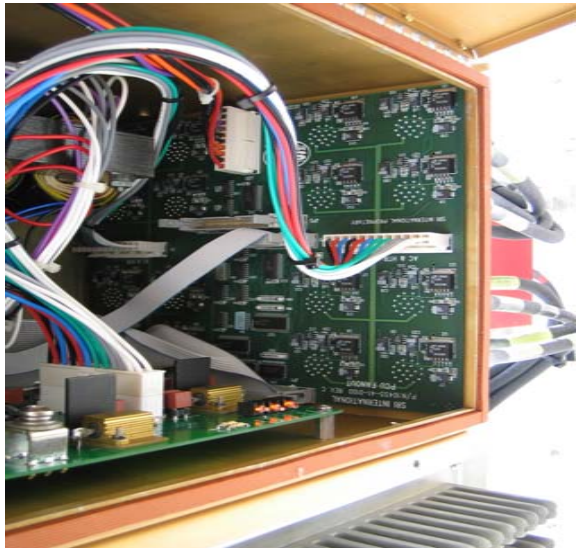
- Engineering
  - Spend Time up Front
  - Cost 10x Later
- Engineering ‘time to complete’ is always underestimated
- Unexpected costs
- Do the experiment and learn from the change
- Design for all the extremes of the specification
- Utilize 4-corners (Low Temp., Low Humidity, High Temp., High Humidity)
- Adapt **MIL-STD-810F** “Environmental Test consideration”, as needed

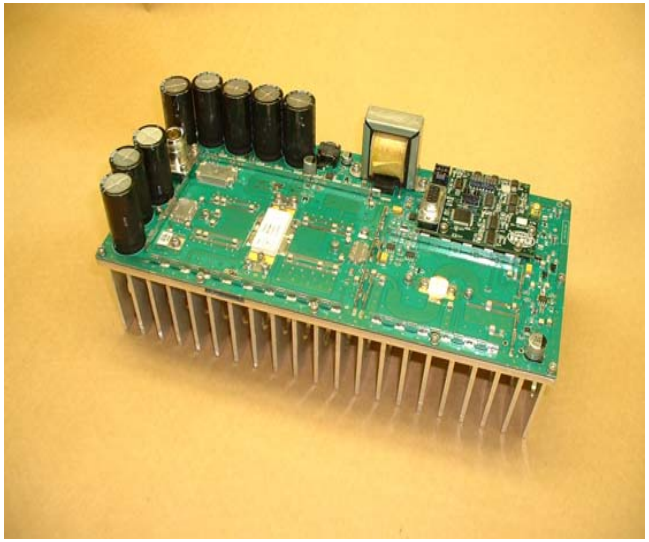
# AMISR Program
## Design Specification

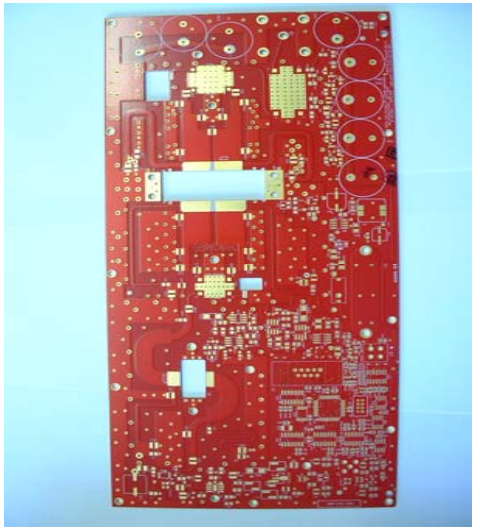
# AMISR Program
## Sub-Components











# AMISR Program
## Advice Steps_Product Documentation

- ***Document the Product.***

# AMISR Program
## Product Documentation

- What is enough?

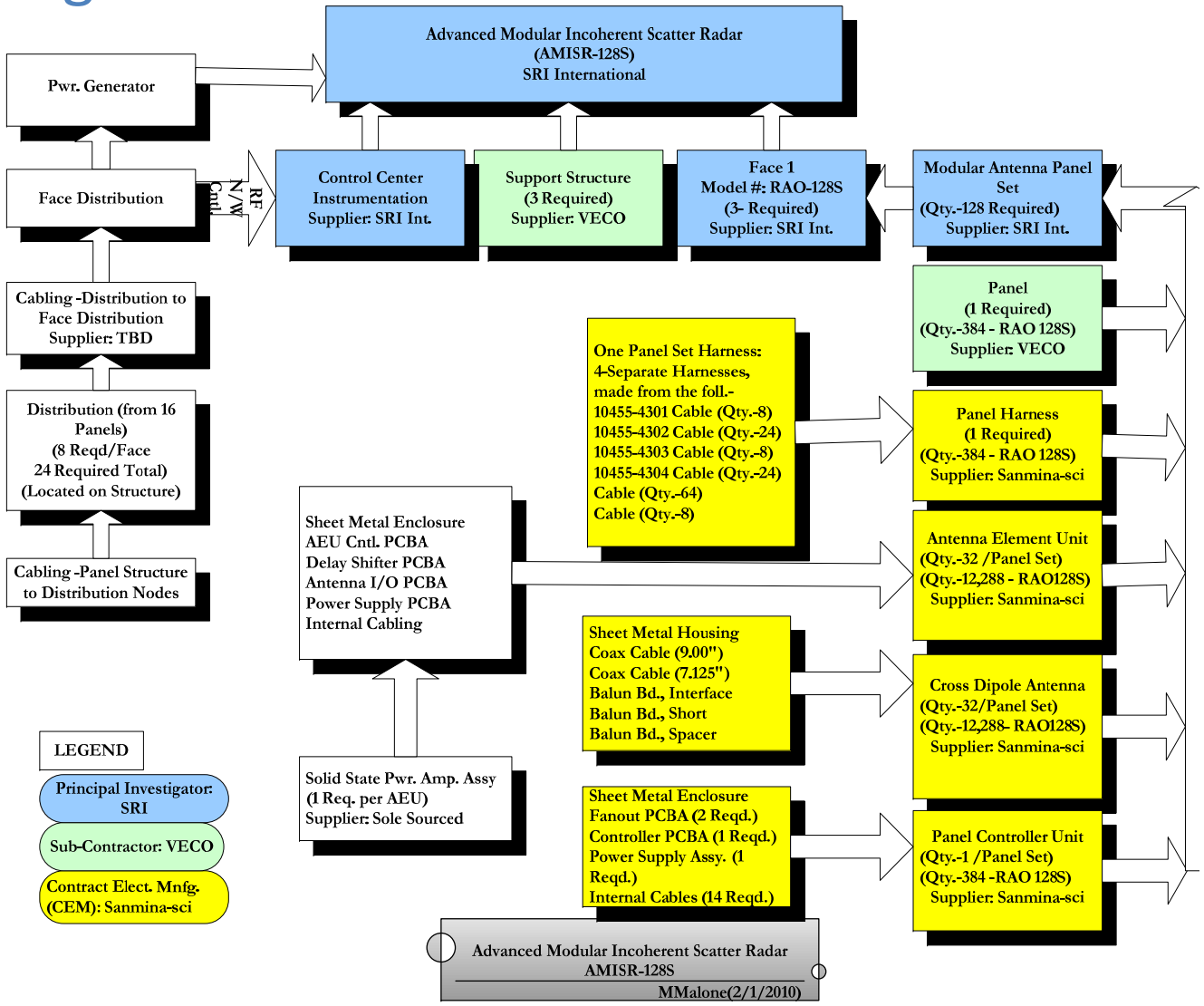
*"Sufficient to be able to successfully repeat Production of the product to the correct Configuration Level".*

- As Early as Possible in the Design Cycle

*"Establish a Configuration Management Process, a Part # Reporting Structure"*

# AMISR Program
## Product Engineering Architecture

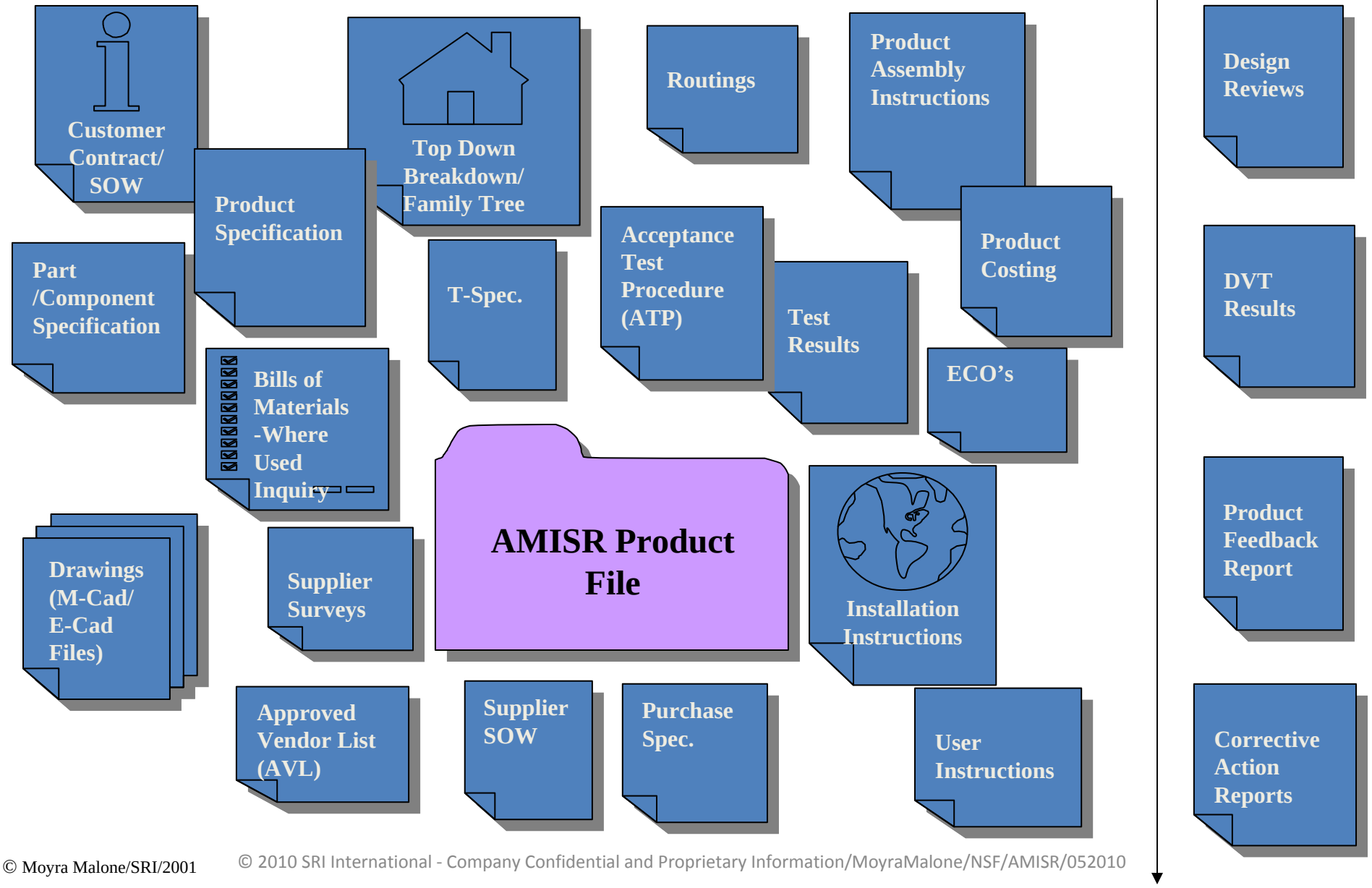
- **Radar Face**
  - **Support structure, Decking, Stairways, Cable trays**
    - **Power Cable**
    - **RF Cable**
    - **Fiber Cable**
  - **128 Panels**
    - **128 Panel Controllers**
    - **128 Panel Cable Harness**
    - **768 Splitters/combiners**
    - **4,096 Antenna Element Units**
  - **Utility Distribution Units, 2 ea.**
    - **8 PMCUs**
    - **16 CPDUs**
    - **16 HPTUs**
    - **16 Power Converters**
  - **Data Acquisition System**



# AMISR Program
## Elements of a Product Documentation Package

- Product Specification
- Engineering Information
  - Component Spec. / Piece Part Information
  - Sub-Assembly Drawings
  - Assembly Drawings
  - Integration Level Drawings
- Purchase Specifications
- Bill of Materials (BOM)
- T-Spec
  - Acceptance Test Procedure (ATP)

# AMISR Program
## Product Documentation Files



# AMISR Program
## Advice Steps_ Supply Chain

- **Find the**
  - ***"Best Strategic Partners and Component suppliers".***

# AMISR Program
## Supplier Selection

| | Traditional Selection | Strategic Partner | SRI Needs |
|---|---|---|---|
| **Selection Process** | Cost is Primary.<br>Multiple Sources.<br>Suppliers Bid for Business. | Select Best Suppliers.<br>Few Sources.<br>Quality of Service & Delivery + Cost | ***Strategic Partners.***<br>***Approved Vendor List (AVL).*** |
| **New Products** | Meet Specifications.<br>Late Supplier Involvement.<br>Toss "documents over". | Supplier Design Suggestions (DFx).<br>Early Supplier Involvement. | ***Development Ideas.***<br>***Brand Identification.*** |
| **Cost** | Lowest Cost Wins.<br>Negotiate based on leverage. | Provide Fair Return.<br>Negotiate based on Trust.<br>Materials Costs Change | ***Best Service.***<br>***Complimentary Development.*** |
| **Quality** | Acceptance Levels.<br>Supplier's Responsibility. | Joint Effort.<br>Function of Design & Process.<br>Continuous Improvement. | ***First Class Products.*** |
| **Relationship** | Short Term.<br>Arms Length.<br>Overpower the supplier. | Partnership, long term involvement.<br>Work to complement each other. | ***Manufacturing Partners.***<br>***It's about PEOPLE.*** |

# AMISR Program
## Supplier Identification Strategy

- Few, Top Class Suppliers
- Located as close to SRI as possible
- High Quality

- Ongoing Performance Assessment
  - Key Performance Indicators
    - Cost
    - Quality
    - Schedule

- Long-Term contract
- Management of the Supplier's supplier

# AMISR Program

## Key Suppliers_Approved Vendor List (AVL)

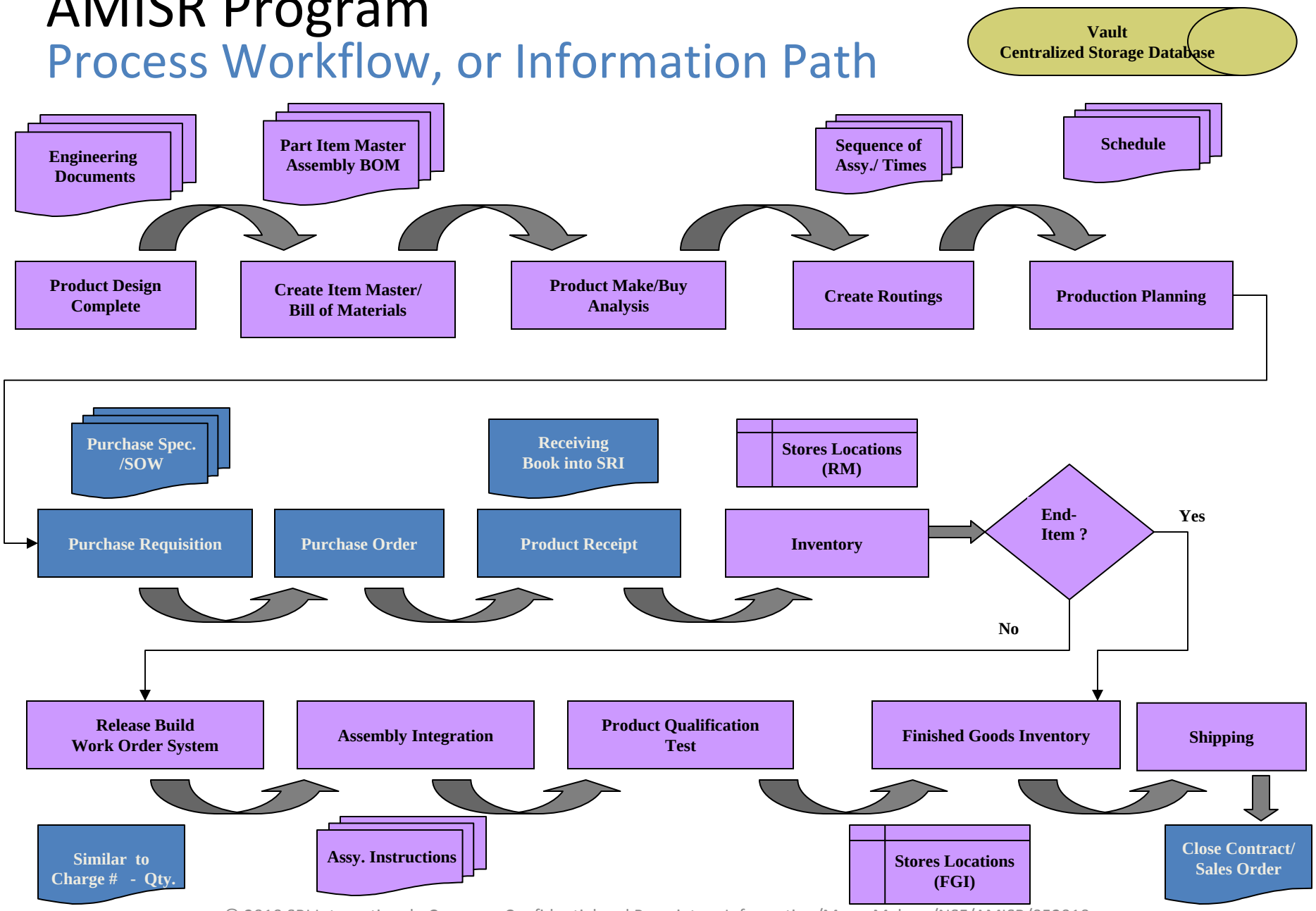
# AMISR Program
## Manufacturing Partner_Sanmina-sci Corporation

# AMISR Program
## Advice Steps_Manufacturing Process

- **Understand it**
  - ***"The Process of Manufacturing is a Complex one".-MM***
  - ***The Integration of various products***
  - ***The Product Process***
  - ***The Logistics***

# AMISR Program

## Process Workflow, or Information Path



# AMISR Program
## Advice Steps_Product Costing

- **Cost IT**
  - ***Materials, and component pricing is a moving target***

# AMISR Program
## Product Negotiations

- Look past the TRADITIONAL or/MIL-spec system of product costing
- Strategic Partnering allows for negotiation
- Have a close working relationship with all elements of the supply chain
- Sit down with your suppliers
- Discuss the product & process
- Look for avenues for cost savings
- Understand the impact of a **multiplier**
- Allow them to make their profit = they are a partner
- Continuously monitor for market conditions
  - commodity price index of aluminum greatly affects this product etc.

# AMISR Program
## Advice Steps_Product Assembly

- ***Build it***
- ***Have a Broad based Schedule***
  - ***It will change***
  - ***Remain flexible***
- ***A lot is about Risk***
  - ***Minimize It***

# AMISR Program
## Advice Steps_Product Test

- ***Learn the Language of Product Test***

# AMISR Program
## Advice Steps_Test

DVT=Design Verification Test
ATP=Acceptance Test Procedure
ICT= In-circuit Test
AOI=Optical Inspection

***"Invent the Test if there isn't one!"***

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# The Horizon, or Replication of AMISR

# AMISR Program
## Advice Steps_Replication

- ***Have Methodologies in place that allow for the successful replication of the product***
  - ***Configured Bills of Materials***
  - ***Supply Chain***

# AMISR Program
## Product Software Tools

*Software product tool used at SRI*

**Parts List_AEU** — Printed 3/31/2010

**10455-40E_REV M**
ANTENNA ELEMENT UNIT, ENHANCED VERSION

| | | | |
|---|---|---|---|
| Type | PL | User1 | |
| Revision | 0 | User2 | |
| Status | U | User3 | |
| Date | 4/3/2008 | User4 | |
| By | | User5 | |

< NOTES COPIED FROM 10455-40E_REV L >
Updated Input Bd. to Rev L; Added 10455-HD.96 for SSPA.
Added ref. to test s/w_05022005;
06/21/2005: Power Supply Bd. changed to Rev L; part # 10455-40-05.24, updated supplier; LNA Assy. updated to Rev K; Bootloader code on Controller Bd. changed.
REV E1-added AEU Cntl. w/ RJ-11 CABLE(REV G1)
REV F_ADDED AEU CNTL AT REV H
REV G-Removed 10455-40-02/added 13710-40-02.
Removed 10455-40-04_Rev H/replaced with Rev.J//
03142007_REPLACED CNTL BD. REV J W/ REV K.
04/25/2007_10455-40E_REV H, removed AEU Controller, 10455-40-04_Rev K, replaced with 10455-40-04_Rev L.(ECN2007_009)
10/25/2007–AEU REV J-ADDED SSPA AT REV B.
11/05/2007-AEU REV K-ADDED SSPA AT REV C.
01/18/2008-AEU REV L-ADDED SSPA AT REV D.
04/03/2008_AEU REV M_ADDED SSPA AT REV E.

| Item | Qty / Unit | Part Number | Type / Rev | Title / Detail | Reference |
|---|---|---|---|---|---|
| | | Vendor | | Vendor P/N / Mfr Name | Mfr P/N |
| 1 | 1 each | 10455-40-01E_REV L | PL 0 | INPUT BOARD ASSY., ENHANCED VER. WITH IQ DETECTOR<br>Added ref. to test s/w_05022005 | |
| | | SANMINA | | 10455-40-01E_REV L SANMINA | 10455-40-01E_REV L |
| 2 | 1 each | 10455-40-03_REV F | PL F | DELAY SHIFTER ASSEMBLY<br>Added ref. to test s/w_05022005<br>01112007-removed 10455-40-03.45/replaced with 10455-40-03.45R<br>10092007-duplicate AVL info.-changed part # 10455-40-01.08 to 10455-40-08.33 at R42. | |
| | | SANMINA | | 10455-40-03_REV F SANMINA | 10455-40-03_REV F |
| 3 | 1 each | 10455-40-04_REV L | PL 0 | CONTROLLER BOARD, AEU<br>Removed 10455-40-04.49, replaced w/10455-40-04.49_Rev A.<br>ECN2006_002: Removed U42/Removed R33/Added Jumper Wire/Added 10455-40-04.56/Added Header to replace U42<br>Included REV G1(ECN2006_004.REV1)<br>01092007—REV J–Added 10455-40-04.63/10455-40-04.64/<br>Moved 10455-40-04.57/.58 to TLA/Changed quantity 10455-40-04.02/Added 10455-41-01.32/Changed P/N10455-40-04.12R/Changed quantity 10455-40-04.54/<br>Removed 10455-40-04.56/10455-40-04.60/Changed Revision of PCB./Removed 83001-05/ADDED R33/Removed 10455-40-04.61.<br>REVISION K-Changed PCB due to Layout errors.<br>REVISION L_ ECN 2007-009-Deleted R33 (10455-40-04.15); Changed PCB Rev level to Rev L.<br>Changed schematic.Changed p/n 10455-40-04.12R back to 10455-40-04.12 for Sanmina purposes. | |
| | | SANMINA | | 10455-40-04_REV L SANMINA | 10455-40-04_REV L |

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333 Ravenswood Avenue, Menlo Park, CA 94025
650-859-2893

# AMISR Program
## Resolute Bay, Canadian South Face (C-ISR)

# AMISR Program
## Replication of Facilities

- Antarctica AMISR (MAISR)
  - Proposal submitted to NSF January 2010
    - Office of Polar Programs
    - Two (2) ea. ISR's
    - Program Value, ~ $48m
    - <Y2013
- Argentina
- Andøya
- European EISCAT 3D
  - SRI would like to assist in the Design for Manufacturability and Production of EISCAT 3D

# AMISR Program
## Summary

- Apply a Systems Engineering Concept
- Focus on Product Reliability
  - Measurement of
  - Demonstrated
- Understand the Product Life Cycle
- Design, for
  - Modularity
  - Component/Assembly Replacement
  - Assembly, Ease of
- Partner with the Best possible in the Supply Chain
- Remain Flexible
- Maintain Concurrent Engineering

# AMISR Program
## Advice Step_ to NSF

- ***Typically, NSF awards contracts to Universities, not-for–Profit research centers etc., where the product management tools are not available.***

- ***Recommendation from SRI International***

# AMISR Program
## Recommendation

- *"That NSF investigate providing current market software tools to manage these mid-large scale complex programs". –MM*
  - PLM systems, such as Siemens Teamcenter

- Benefits
  - Uniform approach to a Product Lifecycle Management (PLM) environment
  - Facilitate the utilization, common product platforms
  - Central Control of data on funded projects
    - data management, program management, change management, configuration management and export control
  - Single source for managing and sharing access to the program and product knowledge and their related processes.

- Requirement
  - Serviceability of product in later years
  - Knowledge Transfer